DEC STD 103-4 Electromagnetic Compatibility (EMC) —Electromagnetic Susceptibility (Immunity)

DOCUMENT IDENTIFIER: A-DS-EL00103-04-0000 Rev A, 01-Oct-1992

ABSTRACT: This standard defines acceptable levels of electromagnetic immunity against interference from radio and television transmitters and other electromagnetic equipment for products manufactured or purchased for resale by Digital. It provides test methodology and immunity levels aimed at compliance with the EC directive about EMC (89/336/EEC) as well as additional requirements proprietary to Digital. Other sections of DEC STD 103 are required in addition to this standard to fulfull the requirements under 89/336/EEC.

APPLICABILITY: The requirements of this standard are mandatory for all products that are sold worldwide by Digital with a first customer ship date on or after the release date of this standard. Volume-manufactured devices and systems that were approved according to DEC STD 103-0, Revision B, Chapter 4, do not require redesign to meet the technical requirements of this revision prior to 01-Jan-1996.

NOTE: Products that do not meet this standard will not qualify for a CE label and may face marketability problems in Europe.

Class 1 immunity levels are for light industrial, office, and residential environments. Class 2 immunity levels are for heavy industrial environments. All products shall be tested and documented to enable evaluation at both levels where appropriate.

STATUS: APPROVED 01-Oct-1992; use VTX SMC for current status.

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CONTENTS

1 INTRODUCTION 1
1.1 SCOPE 1
1.2 IMPLEMENTATION 1
1.3 WAIVERS 2
1.4 PRODUCT TEST DOCUMENTATION 2
1.5 PERFORMANCE CRITERIA 2
1.6 QUALITY ASSURANCE REQUIREMENTS 2

2 POWER LINE TRANSIENTS 3
2.1 SCOPE 3
2.2 CALIBRATION 3
2.3 TEST PROCESS 3
2.4 LIMITS 3

3 RADIATED FIELDS 5
3.1 SCOPE 5
3.2 CALIBRATION 5
3.3 TEST PROCESS 6
3.4 LIMITS 7

4 FAST TRANSIENTS (BURSTS) FOR POWER AND DATA CABLES 9
4.1 SCOPE 9
4.2 CALIBRATION 9
4.3 TEST PROCESS 9
4.4 LIMITS 10

5 POWER LINE FREQUENCY FIELDS, 50 AND 60 HZ 11
5.1 SCOPE 11
5.2 CALIBRATION AND TEST PROCESS 11
5.3 LIMITS 11

6 CONDUCTED INTERFERENCE ON SIGNAL, DATA, AND CONTROL LINES 12
6.1 SCOPE 12
6.2 CALIBRATION AND TEST PROCESS 12
6.3 LIMITS 12

Appendix A TEST DATA SHEETS 13

Appendix B REFERENCED DOCUMENTS 19

B.1 EL-Class Digital Documents 19

B.2 Other Documents 19

B.3 Ordering Information 19

FIGURES

1 Typical Absorber-Lined Chamber 6
2 26 to 1000 MHz Immunity Typical Test Configuration for Tests in Absorber-Lined Chamber 8

TABLES

1 Performance Criteria 2
2 All Single-Phase Equipment Rated Less Than 12 A rms, 100 to 120 V, or 200 to 240 V rms 3
3 All Single Phase Equipment Rated 12 A rms or More, or Three Phase Equipment Independent of Input Voltage 4
4 All DC Power Interfaces 4
5 Radiated Fields Limits 7
6 All Ports That Can Be Connected to Data Cables 10
7 Power Line Frequency Fields Limits 11

1 INTRODUCTION

This standard defines immunity test requirements for electronic equipment intended for use in light industrial, commercial, and residential environments. The immunity test requirements are in relation to continuous and transient, conducted and radiated disturbances, including electrostatic discharges.

The following text defines realistic electromagnetic immunity levels and test procedures that:

Provide sufficient protection against the effects of commercial radio and TV transmitters, as well as other electromagnetic spectrum pollution from industrial processes.

Meet requirements of part EN50082 *Electromagnetic Compatibility, Generic Immunity Standard, Part 1: Residential, Commercial and Light Industry.*

The requirements of this standard apply to all products designed or sold by Digital when mounted, installed, or integrated in actual installation.

These requirements specifically include third-party and buy-out products imported by Digital into Europe (the European Community [EC] and European Free Trade Association [EFTA] countries), as well as products designed and manufactured by Digital.

The test laboratory staff is responsible for determining the appropriate equipment under test (EUT), the system test configuration, and the appropriate test procedures.

1.1 SCOPE

This standard for immunity applies to electrical and electronic equipment intended for use in light industrial, commercial, and residential environments. The requirements are identified as *Class 1* in this document.

The requirements identified as *Class 2* are intended for equipment installed in locations serviced by industrial power networks or by special power supply sources. They are identified for reference only and are not intended as general product requirements. However, products should be tested whenever possible to class 2 requirements in order to gather information regarding product performance.

To meet the requirements for the CE mark, compliance to *DEC STD 103-3 Electromagnetic Compatibility (EMC)—Electromagnetic Interference (EMI) Requirements* and *DEC STD 103-5 Electromagnetic Compatibility (EMC)— Hardware Design Requirements for Electrostatic Discharge (ESD) Immunity* is also required.

1.2 IMPLEMENTATION

The requirements of this standard are effective as of the approval date of this standard.

The documentation, calibration, and procedural requirements of other sections of *DEC STD 103 Electromagnetic Compatibility (EMC)* also apply.

1.3 WAIVERS

Where requirements of this standard impose an unreasonable burden for the product, and the requirements are under the Digital proprietary section of this document, the engineering group may seek a waiver to these requirements.

Requests for such a waiver must be substantiated with a problem statement, cost and time estimates to correct the problem, and must be agreed to by the EMC group, Manufacturing, Digital Services, and the EMC domain manager.

Products under waivers may not be acceptable for sale in Europe and may require changes on the product label (or have the CE label removed) to indicate that the products under waiver do not meet legal requirements for sale in certain geographical areas.

1.4 PRODUCT TEST DOCUMENTATION

Qualification tests will be documented in sufficient detail to allow the test to be repeated, based on the test report information. Qualification reports will be mailed to the EMC domain office for archiving, for obtaining product approvals from outside regulatory agencies, and as a basis for issuing declarations of compliance. Suggested formats for data sheets are included in the appendices to this document.

Further requirements are listed in *DEC STD 103-1 Electromagnetic Compatibility (EMC) - Documentation and Approval Process*.

1.5 PERFORMANCE CRITERIA

The categories listed in Table 1 represent the test performance criteria.

Table 1: Performance Criteria

A	The apparatus, system, or device under test shall continue to operate as intended. No degradation of performance, loss of function, or loss of data is allowed.
B	The apparatus, system, or device under test shall continue to operate as intended after the test. Performance may be degraded during the test; however, no loss of data, erroneous data, or functions may occur during the test. Full performance is restored automatically after the test without the need for any operator or user intervention.
C	Temporary loss of function during the test is allowed, provided the functions are self-recoverable or can be restored by the operator. If permanent loss of data occurs, the operator must receive an indication that such has happened.

1.6 QUALITY ASSURANCE REQUIREMENTS

Products that receive approval for First Revenue Ship (FRS) on or after 01-Jan-1994 must incorporate the requirements of this standard as part of any audit plans as described in *DEC STD 103-7 Electromagnetic Compatibility (EMC) - Quality Process*. The audit plan includes physical inspection to a Critical Features List (CFL) instead of, or in addition to, testing.

2 POWER LINE TRANSIENTS

A power line transient is an aperiodic, single polarity, short duration voltage perturbation. Such transient voltages generally have a short rise time and an overall duration of less than 1 ms and may be of either polarity.

2.1 SCOPE

These requirements are applicable to all AC power line interfaces intended for connection to commercial power with nominal ratings of 100 to 120 V rms and 200 to 240 V rms, 50 or 60 Hz.

2.2 CALIBRATION

Any transient or surge tester must be calibrated at least yearly, or more often if required according to the manufacturer of the tester.

2.3 TEST PROCESS

Use the process defined in the subhead titled "Application of Performance Susceptibility Waveforms" in *DEC STD 122-0 AC Power Line Standard: Design Requirements and Guidelines.*

2.4 LIMITS

The transient voltage is the actual peak voltage over and above the normal AC voltage from the power source.

Impulses should be 1.2/50 (open voltage) - 8/20 (shorted) µs combination wave impulses of specified magnitude and coupling mode, with 10 pulses at random times with respect to the AC power line phase in each polarity (positive and negative). The average power of these impulses over the test duration should not exceed 0.5 Watt, as defined in DEC STD 122-0, and 2.5 Ws per pulse (to prevent overloading metal-oxide varistors (MOVs).

Both performance criteria A and B apply.

Table 2: All Single-Phase Equipment Rated Less Than 12 A rms, 100 to 120 V, or 200 to 240 V rms

	Performance Criteria A (no loss of function)		Performance Criteria B (self-restoring)	
	Class 1	Class 2	Class 1	Class 2
Differential mode	0.5 kV	1 kV	1 kV	1.5 kV
Common mode	1 kV	2 kV	2 kV	3 kV

Table 3: All Single Phase Equipment Rated 12 A rms or More, or Three Phase Equipment Independent of Input Voltage

	Performance Criteria A (no loss of function)		Performance Criteria B (self-restoring)	
	Class 1	Class 2	Class 1	Class 2
Differential between phase and neutral	1 kV	1 kV	1.5 kV	1.5 kV
Common mode	2 kV	2 kV	3 kV	3 kV

Table 4: All DC Power Interfaces

Under consideration. Not required in this version.

3 RADIATED FIELDS

The following subheads describe test requirements for radiated fields.

3.1 SCOPE

This section corresponds to EN50082 which, in turn, is based on IEC 801 *Electromagnetic Compatibility.* At frequencies below 80 MHz, testing is also performed by impressing a radio frequency (RF) signal on all power and data cables with an amplitude based on the level of the radiated field.

3.2 CALIBRATION

The indirect (current injection) test setup is calibrated by measuring the induced voltage from the current injection probe on a long wire terminated into 50 Ohms. The same power necessary to reach the required induced voltage for the selected test level (1 or 2) is applied to the probe when the EUT is tested.

The (direct) radiated test is performed in an anechoic room in which the field uniformity over the front surface of the EUT(s) is established prior to the actual testing in an empty semianechoic room (Figure 1).

The virtual front surface of the EUT is defined as a vertical plane of 1.5×1.5 meters with its bottom edge parallel to the floor at a height of 0.8 meters.

The illuminating antenna should be 3 meters from the front surface (1 meter may be used where space constraints require; however, the 3 meter distance test takes precedence in case of disputes). Identical antennas for immunity measurements and calibration shall be used.

The radiated field shall be measured at each point of a 0.5 meter interval grid on the 16 resulting points.

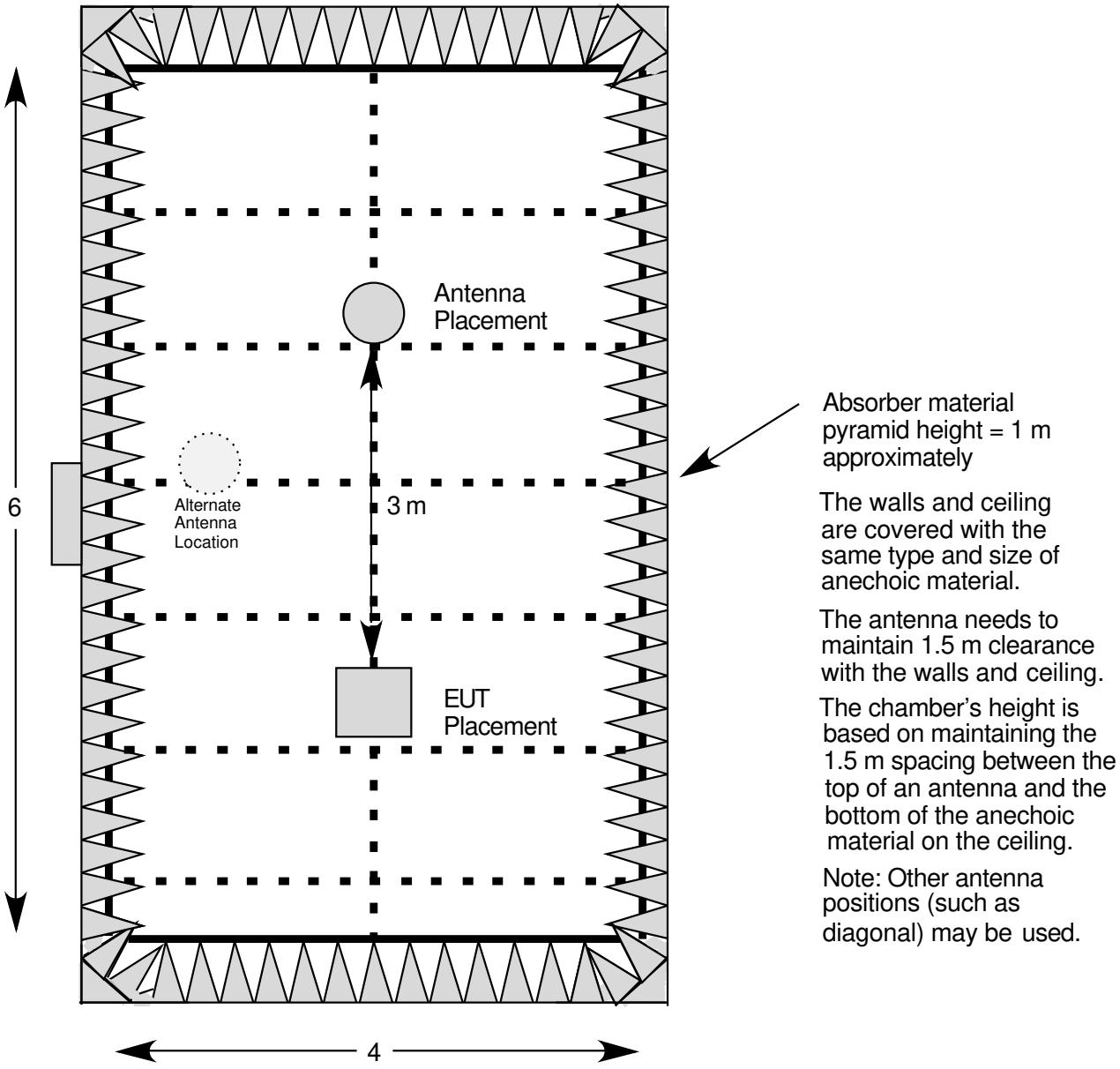
The room is considered acceptable when, for each calibration frequency, 12 of the 16 points are between 3 and 6 V/m (0 to +6 dB); it may be necessary to place anechoic (ferrite) material on the floor of a semianechoic room between the EUT location and the radiating antenna to achieve these values. At different frequencies there may be a different selection of 12 of the 16 points.

Calibration of the anechoic room shall be performed for both horizontal and vertical polarization and by either sweeping the frequency, or testing in discrete steps as follows:

At 26 MHz
Every 10 MHz between 30 and 200 MHz
Every 25 MHz between 200 and 500 MHz
Every 50 MHz between 500 and 1000 MHz

At each frequency, the forward power into the transmitting antenna required to obtain 3 V/m (or any other target field strength) shall be recorded.

Figure 1: Typical Absorber-Lined Chamber


Antenna Placement
Alternate Antenna Location
3 m
EUT Placement
6
4
Absorber material pyramid height = 1 m approximately
The walls and ceiling are covered with the same type and size of anechoic material.
The antenna needs to maintain 1.5 m clearance with the walls and ceiling.
The chamber's height is based on maintaining the 1.5 m spacing between the top of an antenna and the bottom of the anechoic material on the ceiling.
Note: Other antenna positions (such as diagonal) may be used.

3.3 TEST PROCESS

Refer to IEC 801 Part 3:1984 *Immunity to Radiated Fields* and IEC 801 Part 6:1992 *Immunity to Disturbances induced by radio frequency fields above 9 kHz (1992, draft).*

The sweep rate for the RF source shall not exceed 0.0015 decade/second. The RF source shall be 80% AM modulated with a 1 kHz signal.

The test method and frequency range shall be:

Conducted current injection on all power and data cables from 10 kHz to 80 MHz

Radiated field from 26 MHz up to 1000 MHz and at 1.8 GHz

The conducted current injection test is performed by clamping a RF current probe over the cable or placing an impedance stabilizing network (ISN) in series with each cable in succession. All other cables are draped from the EUT to the floor of the test room and run directly on top of the ground plane to the point were they leave the test area.

The radiated test is performed over the most sensitive face (side or surface) of the EUT. If all faces need to be evaluated, it is sufficient to illuminate the EUT at positions corresponding to 0, 90, 180, and 270 degrees.

Use of both horizontal and vertical antenna polarization is required. Where the EUT (which can be a system) exceeds the calibrated area for radiated field testing, the EUT or system may need to be moved with respect to the radiating antenna to illuminate the front face and other rotational positions of the EUT in successive steps.

Where the EUT cannot practically be raised to stand on a 80 cm high (nonconductive) table, it can be placed on a 10 cm high nonconductive support (pallet). In this case, the field strength shall be recorded during the room calibration on the 30 cm high extension of the 1.5 $\times$ 1.5 meter grid.

These four 30 cm high points are not considered for the calibration of the room, but shall be noted in the test report for the EUT.

3.4 LIMITS

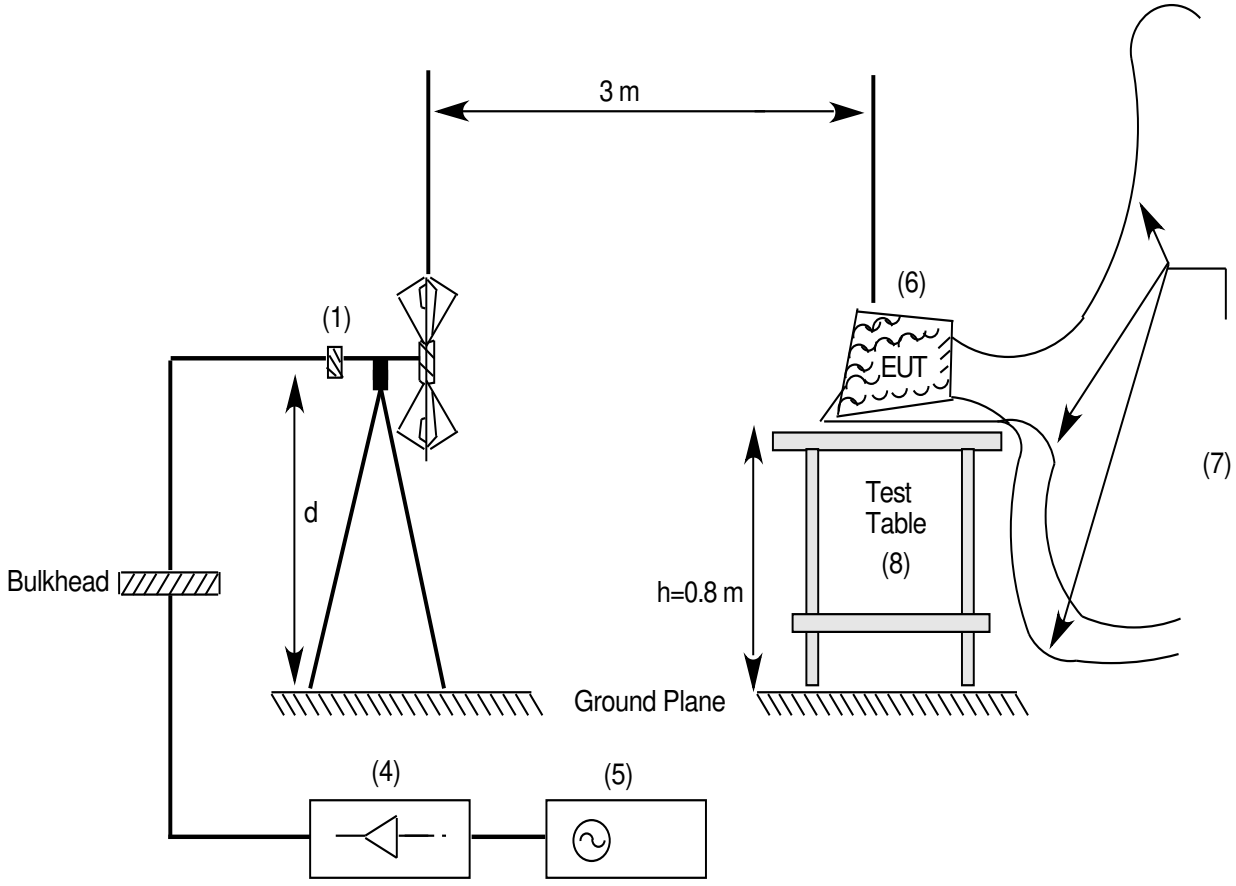
Apparatus or systems tested must properly operate without the need for operator intervention under the following conditions:

Table 5: Radiated Fields Limits

	Performance Criteria A (no loss of function)	
Frequency (MHz)	Class 1	Class 2
0.01 to 80	Under consideration. Not required in this version.	
26 to 1000	3 V/m	10 V/m
1800	Under consideration. Not required in this version.	

All tests shall be conducted at Class 2 immunity levels, wherever possible. Products that do not pass at Class 2 levels may be retested at Class 1 levels. However, for products that require testing at both levels, the test data and results for both levels must be included in the report(s).

Figure 2: 26 to 1000 MHz Immunity Typical Test Configuration for Tests in Absorber-Lined Chamber



KEY:

(1) Transmit antenna: Biconical or equivalent (30 – 200 MHz), Logperiodic or equivalent (200 – 1000 MHz)
(4) Amplifier
(5) Signal generator
(6) Equipment under test (EUT)
(7) System cables
(8) Wooden test table (Not used for floorstanding EUT)

d = Height of antenna centerline from the ground plane. 'd' will vary from 1 m to 2 m
h = Height of base of EUT above floor; floorstanding EUT shall be placed on a 10 cm high nonconductive support (pallet).

4 FAST TRANSIENTS (BURSTS) FOR POWER AND DATA CABLES

Electrical fast transients are induced voltages on power and data cables.

4.1 SCOPE

This segment corresponds to EN50082 which is based on IEC 801 Part 4 *Electrical Fast Transient/Burst Requirements.*

Tests are performed on all power and data cables that are or can be attached to the device under test.

4.2 CALIBRATION

The electrical fast transient (EFT) generator must be calibrated according to the manufacturer's recommended schedule, and the calibration records must be maintained in the facility using this specific test equipment.

Coupling devices that are substantially mechanical do not need to be calibrated, but are subject to a physical inspection at intervals of one year.

4.3 TEST PROCESS

Refer to IEC 801 Part 4 *Electrical Fast Transient/Burst Requirements (1988)* .

Data cables are placed inside the coupling clamp and subjected to at least the stated transient levels for a minimum of 10 minutes. During this time, system level diagnostics or other special purpose programs are run to determine possible errors in the operation of the EUT.

Support devices necessary for the proper operation of a system, but which are not part of the EUT, may be physically removed or isolated from the test area, provided they remain an active part of the system.

An EUT that has multiple possible interconnections and permutations of input/output (I/O) card modules and types of data cables (with shielded, unshielded, and different connectors) shall be subject to this test in all possible I/O interconnection permutations.

Power cables are normally tested by injection of the EFT transient into the power cable conductors through a LC coupling network.

If such a network is not practical because of the high amperage of the EUT, the test may be made using the coupling clamp normally associated with data cables. However, the test levels (limits) shall be twice as high.

4.4 LIMITS

Data cables are measured with a 1-meter coupling clamp, and power cables are tested with a direct coupled LC network. If power cables are tested with the 1-meter coupling clamp, the values shall be doubled.

Test to performance criteria B (self-restoring), described in Table 5.

Table 6: All Ports That Can Be Connected to Data Cables

	Performance Criteria B (self-restoring)	
	Class 1	Class 2
Data cable longer than 3 m	0.5 kV	1 kV
Data cable longer than 10 m	1 kV	2 kV
Power cables[1] (AC or DC)	1 kV	2 kV

[1]Except for permanently connected power cables with a length not exceeding 2 meters between parts of a system.

5 POWER LINE FREQUENCY FIELDS, 50 AND 60 HZ

The following subheads describe the test requirements for power line frequency fields.

5.1 SCOPE

Not required in this revision. Testing should be done for information only. This segment is expected to become mandatory in the next version.

5.2 CALIBRATION AND TEST PROCESS

See IEC TC77B(CO)7 *Electromagnetic Compatibility (EMC), Part 4: Testing and measuring techniques, Section 8: "Power frequency magnetic fields" immunity test.*

5.3 LIMITS

Test to performance criteria A.

Table 7: Power Line Frequency Fields Limits

	Performance Criteria A (no loss of function)	
	Class 1	Class 2
All products[1]	3 Gauss	10 Gauss
CRTs[2]	0.02 Gauss	0.02 Gauss

[1]No errors. However, screen distortion and color changes on CRTs are allowed, but must be noted in the report.

[2]CRT displays must have acceptable display quality.

6 CONDUCTED INTERFERENCE ON SIGNAL, DATA, AND CONTROL LINES

The following subheads describe the test requirements for conducted interference on signal, data, and control lines.

6.1 SCOPE

Not required in this revision. Testing should be done for information only. This segment is expected to become mandatory in the next version.

6.2 CALIBRATION AND TEST PROCESS

See *CCITT K20 Protection against Interference, Series K Recommendations, Construction, Installation and Protection of Cable and Other Elements of Outside Plant.*

6.3 LIMITS

Test to 10 V rms, 50 Hz, performance criteria A.

APPENDIX A TEST DATA SHEETS

Test data sheets that can be used for recording test results described in this standard are on the following pages.

An immunity test report must contain these sheets (or similar sheets), properly completed and signed by the person(s) performing the tests.

Test numbers are to be assigned using the first 3 characters that indicate the test facility site code, and a 6-digit numerical sequence assigned by the test facility for that specific test.

A product immunity test report can only refer to *one* test sequence number for each test item, and a compliance report can only cover one specific, identifiable EUT.

Test date:	Test facility/number /	Page of
Test type: High energy transients on AC power lines, DEC STD 103–4, subhead 2		
Performance criteria: [ ] Class (1 or 2) [ ]	AC power interface type [ ] Single < 120V/20A or 240V/16A [ ] Multiphase or > 120V/20A or 240V/16A	
EUT description: S/N: Diagnostic SW: [P] = pass [D] = degraded but self–restoring [F] = Fail		

Test equipment	S/N:	Calibration date
Transient gen:		
Coupling network:		

AC entry designation	Test level kV	Result P/D/F	Coupling mode comm/diff	Notes, comments

Notes

Test date:	Test facility/number /	Page of
Test type: Conducted Current Injection 10 kHz – 80 MHz, DEC STD 103–4, Subhead 3		
Performance criteria: [ ]	Class (1 or 2) [ ]	
EUT description: S/N: Diagnostic SW: [P] = pass [D] = degraded but self–restoring [F] = Fail		

Test equipment	S/N:	Calibration date
Probe:		
Generator:		

IO module Part No.	IO cable Part No.	Level V	Result	Comments

AC Power entry	Level V	Result	Comments

Tested by:	Continuation sheet page [ ]
Notes	

Test date:	Test facility/number /	Page of
Test type: Radiated field Immunity, 26 – 1000 MHz, DEC STD 103–4, subhead 3		
Performance criteria: [ ]	Class (1 or 2) [ ]	
EUT description: S/N: Diagnostic SW: Test control SW: [P] = pass [D] = degraded but self–restoring [F] = Fail		

Test equipment	S/N:	Calibration date
Antenna:		
Antenna:		
Amplifier:		
Amplifier:		
Generator:		

Freq Range MHz	Front H pol. V	Left H pol. V	Back H pol. V	Right H pol. V
26 – 30				
30 – 40				
40 – 60				
60 – 80				
80 – 120				
120 – 170				
170 – 225				
225 – 300				
300 – 400				
400 – 500				
500 – 600				
600 – 700				
700 – 800				
800 – 900				
900 – 1000				

Tested by:	Continuation sheet page [ ]
Notes	

Test date:	Test facility/number /	Page of
Test type: EFT test on data and AC power lines, DEC STD 103–4, subhead 4		
Performance criteria: [ ]	Class (1 or 2) [ ]	
EUT description: S/N: Diagnostic SW: [P] = pass [D] = degraded but self–restoring [F] = Fail		

Test equipment	S/N:	Calibration date
Transient gen:		
Coupling network:		
Other:		

IO Module Part No.	IO Cable Part No.	Level kV	Coupling Method	Result P/D/F	Comments

AC Power Entry	Level V	Result	Comments

Tested by:	Continuation sheet page [ ]
Notes	

Test date:	Test facility/number /	Page of
Test type: Power line frequency fields, DEC STD 103–4, subhead 5		
Performance criteria: [ ]	Class (1 or 2) [ ]	
EUT description: S/N: Diagnostic SW: [P] = pass [D] = degraded but self–restoring [F] = Fail		

Test equipment	S/N:	Calibration date
Field coil:		

Freq 50/60	EUT side	Level Gauss	Result P/D/F	Comments

Tested by:	Continuation sheet page [ ]

Notes

APPENDIX B REFERENCED DOCUMENTS

B.1 EL-Class Digital Documents

EL-Class Number	Document Title
EL-00103-00	*DEC STD 103-0 Electromagnetic Compatibility (EMC) - Overview and Process Requirements*
EL-00103-01	*DEC STD 103-1 Electromagnetic Compatibility (EMC) - Documentation and Approval Process*
EL-00103-03	*DEC STD 103-3 Electromagnetic Compatibility (EMC) - Electromagnetic Interference (EMI) Requirements*
EL-00103-05	*DEC STD 103-5 Electromagnetic Compatibility (EMC) —Hardware Design Requirements for Electrostatic Discharge (ESD) Immunity*
EL-00103-07	*DEC STD 103-7 Electromagnetic Compatibility (EMC) - Quality Process*
EL-00122-00	*DEC STD 122-0 AC Power Line Standard: Design Requirements and Guidelines*

Use VTX SMC to order copies of EL-class documents from Standards and Methods Control. Send distribution questions to JOKUR::SMC or call DTN: 234-4423.

B.2 Other Documents

Document Number	Document Title
CCITT K20	*Protection Against Interference, Series K Recommendations, Construction, Installation and Protection of Cable and Other Elements of Outside Plant*
EN50082	*Electromagnetic Compatibility, Generic Immunity Standard, Part 1: Residential, Commercial, and Light Industry*
IEC 801	*Electromagnetic Compatibility*
IEC 801 PART 3	*Immunity to Radiated Fields*
IEC 801 PART 4	*Electrical Fast Transient/Burst Requirements (1988)*
IEC 801 PART 6	*Immunity to Disturbances induced by radio frequency fields above 9 kHz (1992, draft)*
IEC TC77B(CO)7	*Electromagnetic Compatibility (EMC), Part 4: Testing and measuring techniques, Section 8: "Power Frequency magnetic fields" immunity test*

B.3 Ordering Information

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